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ABSTRACT

From a review of relevant literature and conference reports, guidelines were prepared for assessing the value of automated instructional materials. Major points included: (1) a definition of automated instruction; (2) a comparison of Skinner and Crowder methods; (3) benefits of automation; (4) general sources of automated materials; (5) benefits of teaching machines; (6) compatibility of teaching machines with existing programs; (7) testing of automated systems; (8) cost comparisons; (9) automated instruction as part of a total training program. (EMH)

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GUIDELINES FOR EVALUATING AUTOMATED INSTRUCTIONAL PROGRAMS AND DEVICES

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BUREAU OF NAVAL PERSONNEL

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BRIEF

Some points to consider in evaluating automated instructional programs for Navy training are specified in this report. The following factors are covered:

1. Alleged advantages of automated instruction are reviewed, including claims of better learning, time-saving, reduced attrition, more effective use of instructors, better motivation, and individualized instruction.

2. Characteristics of programs, including types of program, sources of supply, quality, and suitability to training needs.

3. Characteristics of teaching machines, including manufacturers' claims of versatility, mechanical reliability, and convenience.

4. The introduction of automated instruction, including cost, preliminary tryout, and integration with the rest of the training program.

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GUIDELINES FOR EVALUATING AUTOMATED INSTRUCTIONAL PROGRAMS AND DEVICES

INTRODUCTION

There is an increasing demand throughout the Navy for information concerning automated instructional materials. The "teaching machine industry" has expanded rapidly into a lucrative as well as a highly competitive field. One result of this has been the appearance of many newly formed companies offering a wide variety of "programmed" courses and accompanying hardware.

Glaser (1960) has defined programming as "the process of constructing sequences of instructional material in such a way that maximizes the rate of acquisition and retention and enhances the motivation of the student." Extravagant claims sometimes are made regarding the effectiveness of the new materials. In some cases there may be reason to suspect that the program has been too hastily prepared and insufficiently pretested. Furthermore, it is becoming increasingly common to find, in certain subject-matter areas, including several in which the Navy is interested, the same course programmed in a number of rival versions. In such cases it is difficult to decide which one--if any--of the rival programs to adopt. The difficulty is heightened when one is relatively unfamiliar with this new type of educational medium and the principles upon which it is based.

Such considerations emphasize the need for explicit guidelines which can be used in estimating the value of automated instructional materials for Navy training. Recognition of this need for information is evidenced in a recent instruction by the Chief of Naval Personnel (BUPERS INSTRUCTION 1500.50, of 29 November 1961). This report is a first attempt to specify some of the points that should be taken into account in evaluating any programmed material or teaching device. It will be followed by other reports as the need arises and as experience with programmed instruction accumulates.[1]

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[1]Several professional organizations have set up committees for the purpose of formulating standards for

THE MEANING OF AUTOMATED INSTRUCTION[2]

Automated instruction utilizes two kinds of material: (a) a "program" and (b) some type of device for presenting the program to the learner. In popular usage, the latter device has been labelled a "teaching machine," although this term can be extremely misleading for two reasons. In the first place, the "teaching machine" does not teach--it merely displays the program, one item at a time. Secondly, it may not be a "machine" at all. Many programs are displayed through an aperture in a cardboard shield which the student moves by hand, to expose each item in turn; others are printed in book form. Frequently the same program is available for use either with or without a "teaching machine." This fact, however, is not always stressed in the manufacturer's advertising.

Unquestionably, it is the program itself that is of primary importance, not the mechanical arrangements by which it is presented to the learner. All programs have three features in common: (a) the instructional material is carefully organized into a logical sequence of small steps; (b) each step--or "frame" as it is called--is presented in question-and-answer form, so that the learner must actively respond to that frame before going on to the next one; and (c) the learner is immediately informed as to the correctness or incorrectness of each response.

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programmed instructional materials and devices. In May 1961 a joint statement on this matter was issued by committees representing the American Education Research Association, the American Psychological Association, and the Department of Audio-Visual Instruction of the National Education Association, to which committee the present author was recently named a member. This joint statement is reproduced in Appendix A of this report.

[2]The material in this and the following section is largely adapted from an earlier report (Harmon, 1960).

TYPES OF PROGRAM

Programs differ from one another in various ways. As of today, the major distinction stems from two different approaches to the art of programming and gives rise to two basically different types of program.

Skinner and Crowder

One approach is based upon the assumption that, ideally, learning is a smooth, practically errorless process which proceeds by "successive approximations" from ignorance to complete mastery of the subject-matter. "Trial-and-error" learning, it is held, is inefficient and wasteful. Errors retard and interfere with the learning process. They tend to persist and recur, and eventually must be "unlearned." From this it is contended that good programming consists in arranging the material in such short, easy steps that it is almost impossible for the student to make mistakes. At the same time, his correct responses receive constant reinforcement from the immediate knowledge that they are correct, and that he is making progress in his learning task. Programs constructed on these principles are often called "Skinnerian" or "Skinner-type" programs, after B. F. Skinner who has been a leading figure in promoting this approach (Skinner, 1954, 1958).

The other type of program reflects a different concept of learning--a view that is expressed in the saying, "We learn from our mistakes." Errors, in other words, are not regarded as necessarily interfering with progress. Although the steps remain relatively small, the instructional material is organized into fewer and somewhat longer steps. This increases the frequency of incorrect responses as the student works through the program.

A multiple-choice type of item is used, and the "feedback" includes some explanation as to why each response is right or wrong. If the student makes a correct choice, he is directed to proceed to the next frame; if his response was incorrect, he is told to go back and pick another answer. This approach to programming has been developed by Norman A. Crowder (1960); hence the name, "Crowder-type" program.

Linear and Branching

Programs also may be classified according to whether they are "linear" or "branching." A linear program follows, so to speak, a "straight line" from beginning to end. All students follow the same path by working through the same frames. Brighter individuals usually will require less time than duller students to complete the course.

In a branching program, learners do not all follow the same route; the program, to some extent, takes account of individual differences. For example, the student may be directed to skip certain intermediate items following a series of correct responses, or to go back and repeat certain earlier frames after a succession of wrong answers. Sometimes the superior learner may be taken over a special "loop" in which additional material is introduced as enrichment. The student who is experiencing difficulty may traverse a different path in which further practice is provided or the material is programmed in smaller steps. The significance of the term "branching" is obvious, since the pathways followed by different students diverge as they proceed. It is easy to see that a branching program approximates a private tutor, adapting its instruction to the progress and needs of the individual student.

Until fairly recently it was possible to distinguish Skinnerian from Crowder-type programs on the basis of linearity versus branching. The Crowder method of programming, by its very nature, implies branching; consequently, all Crowder-type programs are branching programs. By contrast, Skinner-type programs, until recently, have been mainly linear. At present, however, Skinnerian programmers are beginning to incorporate a certain amount of branching into their work. The essential difference between the Skinnerian and the Crowder approaches, therefore, lies in the method of dealing with errors. One seeks to avoid errors, the other utilizes them in an effort to promote learning.

The prospective customer is often faced with the choice between Skinner-type and Crowder-type programs in the same area--for example, basic electricity, algebra, or electronic trouble-shooting. He should remember that there is as yet no conclusive evidence to indicate that one method of programming is more effective than the other. It is quite conceivable that one type of

program might be better for certain kinds of material, another better for different kinds of material; but the fact remains that, so far, this has never been demonstrated in any subject-matter area. What has been shown experimentally is this: under suitable conditions, students apparently can learn with either type of program.

Obviously, it is unwise to commit oneself to either the Skinner or the Crowder approach "on general principles." It is well to remember, too, that the art of programming is yet in its infancy. New approaches that differ from both Skinner and Crowder are still being tried out. Woolman (1961), for example, disagrees with the Skinnerian concept of errorless learning. By introducing difficult material into his programs in small doses, he seeks to make the learning process more challenging and, therefore, more stimulating for the student. His initial results look promising. To date, however, Woolman has not developed any programs for general sale. In any event, it is evident that Skinner and Crowder, between them, have not exhausted the possibilities of effective programming. The administrator will be well advised to keep himself informed of new developments in the years just ahead.

In any case, the thing to do is to look at the specific program. How well does it meet the objectives of the course for which it is being considered? Is another program available which seems to meet these same objectives? How do the two programs compare in topics covered, in emphasis upon particular topics? Can the program be used without a machine, or does it require the purchase of additional equipment? These are the relevant questions to ask at this point--not whether the program is of the Crowder or the Skinner type.

WHAT CAN AUTOMATED INSTRUCTION DO?

Before considering any specific instructional program or teaching device, the administrator should define clearly and explicitly the objectives of instruction. This is an important initial phase in the evaluation process, as implied in the last paragraph. In addition, the administrator should determine what actual benefits he hopes to realize from the new methods. Many advantages have been claimed for automated instruction as compared with more conventional methods of teaching. Most notable among the possibilities are the following:

a. Better learning, as shown in end-of-course achievement tests and/or performance on the job.

b. Time-saving, due to the possibility of completing the course more rapidly.

c. Reduced attrition. Because the successive steps in the learning sequence are made short and easy to take, the failure rate for the course often is cut.

d. More effective use of instructors. Automated instruction can take care of the routine drill that is characteristic of many courses, thus leaving the teacher free to deal with the more significant aspects of his task. At the same time, it often is feasible to teach larger groups by these methods--an important consideration when there is a shortage of qualified instructors in a particular training area.

e. Better motivation. This results from the satisfaction of being able to proceed, step by step, through the program, plus the immediate reinforcement of each correct response. Also, it can be an enjoyable experience for the learner to work with a good program.

f. Individualized instruction. The use of programmed materials makes it possible to combine the desirable features of both individual and group instruction. Thus, each student may be allowed to proceed through the course at his own pace. Again, some programs are to some extent "tailored" to the needs of individual students. One way of accomplishing this is by the technique of "branching," already described.

All of the foregoing claims have received some experimental support, although the evidence is far from complete (see Silverman, 1960; Stolurow, 1961). Results will depend upon many factors: the subject-matter, the effectiveness of present methods of instruction, the program itself, and the way in which it is to be used--e.g., as a sole teaching device, or as a supplement to other methods of instruction (Smith, 1961). All of these factors should be weighed carefully before a decision is reached.

It should be understood, too, that not all the benefits of programmed teaching are likely to be realized in every instance. Some, indeed, may be inappropriate, or even undesirable, in particular cases. For example,

a school may already have solved the problem of large classes and insufficient instructors by the use of closed-circuit television; perhaps this method is proving highly satisfactory. Again, it may not be administratively feasible, especially in a military setting, to permit each student to proceed through a course entirely at his own pace. The result could be a considerable disruption of schedules, since students would be completing the course at different times. One way of handling this problem is to provide additional material for faster learners--taking care, of course, that the supplementary work is not presented as a penalty for finishing early. In any case, the introduction of programmed instruction almost certainly will call for some readjustments in order to integrate these new methods with the rest of the training program and with existing schedules.

The implication of these remarks is clear. Any administrator who is contemplating the use of automated instruction should ask first of all, "What could this program conceivably do for me--in this particular course, in this particular school?" The answer will depend upon a careful appraisal of present facilities, needs, and any special training problems that may exist.

In connection with the question of what automated instruction can do, the following point also is worth noting. Persons unfamiliar with the principles upon which it operates, often obtain a very erroneous impression the first time they see a program--particularly one of the Skinner type. Superficially, the question-and-answer form is apt to suggest rote learning, and nothing more. Actually, however, a properly designed program can--and does--teach the understanding of principles as well as facts. Students who have learned a subject by automated instruction are able to generalize their knowledge outside the immediate learning situation. In other words, the prospective purchaser must not allow himself to be misled by surface appearances.

HOW PROGRAMS ARE OBTAINED

Automated instructional materials are obtained today in one of three ways: (a) by purchase of standard, commercially available programs; (b) by contracting for the development of a program specially designed for the purchaser; and (c) by developing one's own program.

a. Commercially available programs. At present this is the largest single source of such materials. Many firms are already engaged in preparing programs for sale, and new companies are constantly appearing upon the scene. At the same time, a number of textbook publishers are entering the programming field. Currently, some 300 "commercial" programs in a variety of subject-matter areas are on the market. Many deal with course materials that appear in line with Navy interests (e.g., mathematics, computer arithmetic, physics, electricity, and electronics).

The advantages of these standard programs are fairly obvious. They are readily available. Although some are relatively expensive, the immediate cost may be less than that of a specially prepared program, developed under contract.

On the other side of the picture, possible disadvantages are equally obvious. Depending upon the manufacturer and the programmers employed, the product may vary considerably in quality, even within the same field. Where the curriculum is specified in detail, as in Navy technical schools, it may be impossible to find a program which exactly fits the requirements, either as to content or as to length. Finally, the program may be usable only with special display equipment which itself is expensive.

b. Programs developed by contract. The chief advantage of such programs is that they are constructed specifically to fit the training needs of the consumer. Another plus factor is that contractors specializing in this work have the necessary skilled programmers available. The chief disadvantages are the time required to develop the program, and a relatively high initial expense. In the long run, however, the cost actually may be less than for a "prefabricated" program. This is true because the purchaser becomes the owner of the program and, therefore, can duplicate it at a lower cost per copy than would be involved in purchasing copies of a commercial program.

Examples of this approach are the four-week program in basic electricity, recently developed for use in Navy schools by Teaching Machines Incorporated, and a contract for a program in trouble-shooting that has been awarded to the Philco Corporation.

c. "Home-made" programs. From many points of view, this probably represents the best answer to the problem of obtaining such materials. Not only will the programs be specifically tailored for particular courses, but they can be revised readily and kept up to date as course content changes. A large organization like the Navy, with its varied and extensive training needs, almost certainly would find it more economical to maintain its own programmers rather than to rely upon outside sources. The main difficulty at present is the lack of competent programmers. One solution is to train one's own--a procedure which is variously estimated to require from four to six months.

The discussion that follows is oriented primarily toward the evaluation of commercially available programs and teaching machines. This seems appropriate because, for the present at any rate, it is the "ready-made" type of instructional material that the Navy administrator will be called upon most often to evaluate. However, the basic principles to be described hold good for all types of program. Consequently they are as applicable to those developed under special contract and "home-made" programs as to the commercial variety.

HOW TO EXAMINE A PROGRAM

The examination of any instructional program should always be approached from the standpoint of its intended use. It is futile to ask whether a given program is a "good" one or not. The proper question is: "Good for what specific purpose?" In an earlier report (Harmon, 1960), it was pointed out that the present enthusiasm for automated instruction is not unlike that which followed the first appearance of selection tests. There, too, realization finally came that it is not meaningful to ask about the validity of tests in general; instead, the validity of any given test must be appraised in terms of the use to which that test is to be put. This idea of "specific validity" is equally applicable to instructional programs.

Development of a program is a lengthy and expensive process. There are no short cuts. Briefly, the process involves repeated tryout and revision until it is demonstrated that the program does in fact teach its subject-matter effectively.

There are a number of questions which the customer should consider before purchasing any commercially available program. The answers to these questions will distinguish between a sound program and one that has been hastily prepared for sale and inadequately tested. Any "teaching machine" salesman or manufacturer should be prepared to supply the following information concerning his product. Rothkopf (1961) suggests that it be made a routine practice to append this kind of information as a "label" to all auto-instructional programs.[3]

a. Is the content appropriate to the particular training needs? This question is especially crucial in the case of commercial, "ready-made" programs which have not been "tailored" to the requirements of a particular course. It is well to remember, too, that the title of a program does not always give an accurate indication of its actual content. The program should be examined, preferably by a subject-matter specialist in the area concerned, in order to determine what are its specific behavioral goals, that is, "What does it teach the student to do?" These goals should be spelled out in objective, concrete terms, not stated in generalities. Rothkopf (1961) goes so far as to suggest that they be specified by means of a complete performance test which the student is expected to pass after working through the program.

Another way of specifying goals has been suggested by Kulkharni (1961), of the Educational Testing Service, Princeton, New Jersey. Kulkharni recommends that the manufacturer or salesman be asked to identify the "criterion frames" in the program. These are not teaching frames; their purpose is to test the student's mastery of some fact or principle which constitutes an objective of the course. As far as the learner is concerned, criterion frames usually are indistinguishable from any other frames in the program. If they are listed for the benefit of the prospective customer, he can make a preliminary evaluation of the adequancy of the program by examining these criterion frames.

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[3]The author is indebted to Dr. Rothkopf for his courtesy in providing him with an advance copy of this paper.

A third possibility for specifying behavioral goals is to provide a detailed outline of the material covered by the program. Ideally, the outline that was used in programming the material would be made available. Such an outline would greatly facilitate comparisons between the goals of the program and the training needs of the customer.

b. Is the material well programmed? A detailed answer to this question would require the advice of an expert programmer. If the administrator feels doubtful on this point, he would do well to engage the services of such an expert. On the other hand, a competent teacher who is familiar with the subject-matter should be able to ascertain whether its organization is logical and the procession of steps, orderly. A "good" program calls for frequent responses by the learner. These responses, moreover, should refer to critical rather than trivial aspects of the material. "Good" programs also illustrate each new concept with a variety of examples.

c. How was the program tried out by the manufacturer? No commercial program that has not been adequately pre-tested should be seriously considered for purchase. Information on this point should cover the size of the tryout group, its educational level, intelligence level, level of reading proficiency, scores on pre- and post-instruction performance tests, error-rate for the program, and any other relevant data.

Also, one should inquire as to the conditions under which the tryouts were conducted. How were the students supervised? What incentive systems were used? What were the working schedules? Were the students allowed to proceed at their own pace? Were any supplementary procedures employed, like laboratory exercises, demonstrations or films? Were teaching machines used?

It cannot be emphasized too strongly that information concerning the tryout should be fairly complete and detailed. Partial information provides insufficient evidence of the worth of a program. As a matter of fact, some of the items just mentioned may be actually misleading when considered in isolation (Center for Programed Instruction, 1961). For example, it is possible for a program to show a very low error rate,

yet teach little or nothing. Again, the effectiveness of the program, as measured by achievement tests, may vary with the intelligence of the students, their reading ability, and their initial knowledge of the subject-matter.

d. Does the program require a teaching machine? If so, the cost of introducing automated instruction may be substantially increased.

e. Is the program reusable? All programmed instruction in one way or another involves the principle of active responding on the part of the learner, consequently the material is presented in some question-and-answer form. If the learner is required to record his answers on the program itself, a fresh copy is required for each student. Many programs provide for the recording of answers on separate sheets, the program becomes reusable, and reproduction costs are reduced.

f. Can the program be revised easily? This point is particularly important in scientific and technical areas where new developments frequently call for revisions of course content. For ease of revision, a program should consist of relatively short, well-defined units. The individual frames should be "self-contained," not connected to preceding frames by introductory words and phrases like "for example," "also," "on the other hand." Such connecting phrases make it difficult to add or delete frames without altering other frames.

g. What are the manufacturer's recommendations for use of the program? Naturally, the administrator will wish to weigh these recommendations against his own training situation and needs.

THE TEACHING MACHINE

As mentioned earlier, there are many programs on the market which may be used either with or without a machine. Others are available in forms that require special display equipment which may range in cost from less than $10.00 to several thousand dollars per unit. A separate unit, moreover, may be required for each student.

"Cheating"

Several advantages are claimed for teaching machines. Most frequently mentioned, perhaps, is the argument that machines are "cheat-proof." By various mechanical devices a machine may control the exposure of material in such a way that the student cannot see the correct answer to a frame until after he has recorded his own response; and cannot change the latter, once the correct response has been exposed. This, however, is not always true of the simpler types of device which do not prevent the student from removing the program from the machine and altering his response.

In any event, an overconcern about cheating seems to reflect some misunderstanding of the basic idea of programmed instruction, a misunderstanding which grows out of the fact that the material is presented in question-and-answer form. It looks like a continuous test, but it is not. Its purpose is to teach, not to provide a basis for grading the student. It permits the learner to verify his mastery of the subject-matter as he goes along.

The learning and the evaluative aspects of the situation are two separate things, and they should not be confused with each other. The student should not be graded for his work on the teaching machine. Evaluation of performance is accomplished by an achievement test or some other independent measure. Consequently, cheating is a problem which concerns evaluation, not learning. Furthermore, the student soon discovers that "cheating the machine" by some "short-circuiting" procedure is self-defeating, since the result is lower scores on the test that "counts."

Error-Counting

Another advantage often claimed for the more elaborate types of teaching machine is that they provide an automatic record of the student's errors as he works through the program. This, of course, is important in developing or trying out a new program, or in revising an old one. However, it is scarcely necessary in a routine teaching situation because, as just noted, the student is not to be graded on his performance with the machine in any case. This suggests the need for distinguishing between teaching machines which are to be

used for purposes of research and development, and those intended for ordinary instructional purposes. Obviously, it would be uneconomical to purchase the former when the latter is all that is needed.

Motivating

Finally, it is sometimes contended that teaching machines improve students' motivation, because they are fun to use. This may be so, but the evidence is far from conclusive. Quite possibly, there may be some novelty effect. This, however, could easily wear off. Unsupported "hope" of achieving better motivation can hardly justify the purchase of twenty-five or fifty machines.

Utility

If teaching machines are being considered, however, there are several questions which the prospective purchaser should raise. Chief among them are the following:

a. What programs are available for use in the machine? Not all programs can be used with all machines. Consequently, it is important to ask about the compatibility of the machine with other programs. Failing to determine this, the administrator may find himself saddled with expensive hardware that has a limited range of usefulness, or wedded indefinitely to a single program supplier.

b. Is the machine comfortable for the student to use?[4] This is a more serious question than might appear at first. Some machines are designed so that the student's arm becomes fatigued or cramped when he works for a long time. In other machines, the aperture through which the frames are exposed is so small as to make reading difficult.

c. Is the machine mechanically or electronically reliable? Such reliability cannot always be taken for granted, despite the manufacturer's claims. Even the simplest types of machine have been known to cause trouble by jamming, tearing of the program, and similar difficulties.

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[4]This and the three following questions are suggested by Smith (1961).

d. Can the student readily change the program himself? In some cases an instructor must be called whenever a new program or section of program is needed. Aside from the waste of time, this also entails a considerable waste of instructor skills.

e. What is the capacity of the machine? Smith (1961) suggests that, ideally, a teaching machine should have a capacity of two to three hundred frames--sufficient for about an hour of the average student's time. A smaller capacity than this would require too frequent changes of program, while a larger capacity might prove excessively expensive. Although this standard cannot be applied too rigidly, it does seem to provide a useful rule of thumb.

FINAL CONSIDERATIONS

Before reaching a final decision concerning the purchase of automated instructional materials, the administrator should bear in mind two additional points:

a. Try out the program before purchasing. Obviously, the proof of the pudding is in the eating--the only way to determine what a program can do is to try it out. The administrator should always insist upon doing this before committing himself to any large-scale purchase. Tryouts may be conducted either on an individual basis, with two or three students typical of those who would be using the material, or they might involve a single class treated as a group.

b. Comparative cost is another factor which must be given careful consideration. Automated instruction is expensive, and the initial cost of introducing it may appear excessive. For this reason, comparisons with present methods are best made on a relatively long-range basis, rather than in terms of immediate payoff.

Implementation

Once the administrator has decided to introduce automation into his training program, his next problem is to determine how to use it most effectively. This is not a question of whether students can learn by using the new materials--presumably that fact has already been demonstrated. Nor is it primarily a question

of automated versus conventional instruction. Automated instruction--at least, in the present state of the art--should be regarded as only one part of the total training program. Consequently, the administrator, when he has reached this stage in his thinking, should ask questions like the following: How can these procedures best be integrated with the rest of the training program? Should the entire course, or only selected portions of it, be automated? What portions are most effectively taught by automation--routine drill, problem-solving, factual material, or new concepts and principles? Should automated instruction be incorporated into the regular class sessions, or used as a supplement to them? What is the proper role of the instructor under automated instruction?

Satisfactory answers to questions like these may require some experimentation after the instructional materials have been accepted for use. Automated instruction appears to have many potentialities for Navy training. However, the most effective way of using it undoubtedly will vary from one training situation to another. For this reason, its greatest potentialities in any particular case can be discovered only by on-the-spot explorations of various possible applications.

SUMMARY

This report attempts to specify some of the points that need to be taken into account in estimating the value of automated instructional materials for Navy training. The need for such information is evidenced in a recent instruction by the Chief of Naval Personnel.

From a review of the relevant literature and conferences with organizations and individuals working on the same problem, the following points emerge:

a. Automated instruction utilizes two kinds of material: a "program" and some type of display device or "teaching machine." The latter is of secondary importance, and often is not required at all.

b. At the present time there is no evidence to indicate that either the Skinner or the Crowder method of programming is superior. Under suitable conditions, students can learn with either type of program.

c. Many advantages have been claimed for automated instruction. These include better learning, time-saving, reduced attrition, more effective use of instructors, better motivation, and individualized instruction. All of these claims have received some experimental support, but not all of the benefits are likely to be realized in every instance. The administrator should determine in advance what benefits he expects to obtain from the new methods.

d. Automated instructional materials are obtained by purchasing commercially available programs, by contracting for the development of a specially designed program, or by developing one's own program. At present, "ready-made" programs are by far the most numerous. To date, the Navy has contracted for several of the "tailor-made" variety. In the long run, however, "home-made" programs probably will prove most satisfactory and economical for Navy purposes.

e. The examination of any instructional program should always be approached from the standpoint of its intended use. Questions that the administrator should ask would cover the following points: the appropriateness of program content to training needs, the quality of the programming, the tryout of the program by the manufacturer, the necessity of using a teaching machine, the reusability of the program, ease of revision, and the manufacturer's recommendations for its use.

f. There are many programs on the market which may be used either with or without a teaching machine. If a machine is used, it may add substantially to the cost of automated instruction. The fact that some teaching machines are "cheat-proof" is largely irrelevant, because the student, in any case, should not be graded for his work with the machine itself. Some machines provide an automatic record of student errors; however this may not be necessary in a routine teaching situation. The supposed motivational value of working with a teaching machine is not supported by any conclusive experimental evidence.

g. If teaching machines are being considered for purchase, the administrator should ask about the compatibility of the device with other programs, its comfort and convenience from the student's point of view, its mechanical or electronic reliability, the ease with which programs can be changed, and the capacity of the machine.

h. Before agreeing to any large-scale purchase of automated teaching materials, the administrator should insist upon trying them out for himself, either with two or three "typical" students or with a single class treated as a group.

i. Cost comparisons between automated and present methods of instruction are best made on a relatively long-range basis, rather than in terms of immediate pay-off.

j. Automated instruction should be regarded as only one part of the total training program. In order to determine how to use it most effectively, some experimentation in the actual training situation may be required.

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APPENDIX A

A Joint Statement on Self-Instructional Materials and Devices by Committees of The American Education Research Association, The American Psychological Association, and the Department of Audio-Visual Instruction of the National Education Association, May, 1961.

The use of self-instructional programmed learning materials in teaching machines and similar devices represents a potential contribution of great importance to American education. But this contribution can be realized best only if users have information with which to evaluate self-instructional materials. Accordingly, the following interim guide-lines have been prepared.

1. Teaching machines do not, in themselves, teach. Rather, the teaching is done by a program of instructional materials presented by the teaching machine. Any evaluation of a teaching machine thus requires an assessment of the availability and quality of programs for each type of machine, as well as its mechanical dependability.

2. A variety of programmed materials is becoming available, but not all programs will fit all machines. Thus only those programs compatable with a particular machine can be considered as available for use with it. A list of commercially available programs and devices may be obtained from the Department of Audio-Visual Instruction, National Education Association, 1201 Sixteenth St., N. W., Washington, 6, D. C. (Cost 50 cents).

3. In evaluating the specific content which a self-instructional program purports to teach, the program can be examined to determine what the student is required to do and whether this reflects the kind of competence which the educator wishes to achieve. Like other educational materials, programs labeled with the name of a particular subject matter vary widely with respect to content and instructional objectives.

4. Just any set of question and answer material does not constitute a self-instructional program. One type of self-instructional material proceeds by small steps requiring frequent responses. These steps can be examined to see if they embody a careful, logical progression of the subject matter. Items in such a program are designed so that the student will respond to critical aspects of each item or will perform the important operation which that item was meant to teach. Furthermore such programs generally provide a wide range of examples illustrating each principle or concept.

5. Self-instructional materials are designed to adapt to individual differences by allowing each student to proceed at his own rate. Some types of self-instructional programs further adapt by "branching" to alternate material. For this purpose, questions are designed to diagnose the student's needs and to provide alternate material suited to these needs. The material is designed so that the choice of answer to a particular question determines which items will be presented next. Incorrect answers take the student to items containing information designed to correct the error before continuing through the sequence.

6. An important feature of almost all self-instructional materials is the record of the student's responses which provides a basis for revising the program. The prospective purchaser should ask about the extent to which revision has been based on student response and how the preliminary tryout was conducted.

7. The effectiveness of a self-instructional program can be assessed by finding out what students actually learn and remember from the program. The prospective purchaser should find out whether such data are available and for what kinds of students and under what conditions the data were obtained.

8. Active experimentation with self-instructional materials and devices in school systems is to be encouraged prior to large scale adoption.